

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

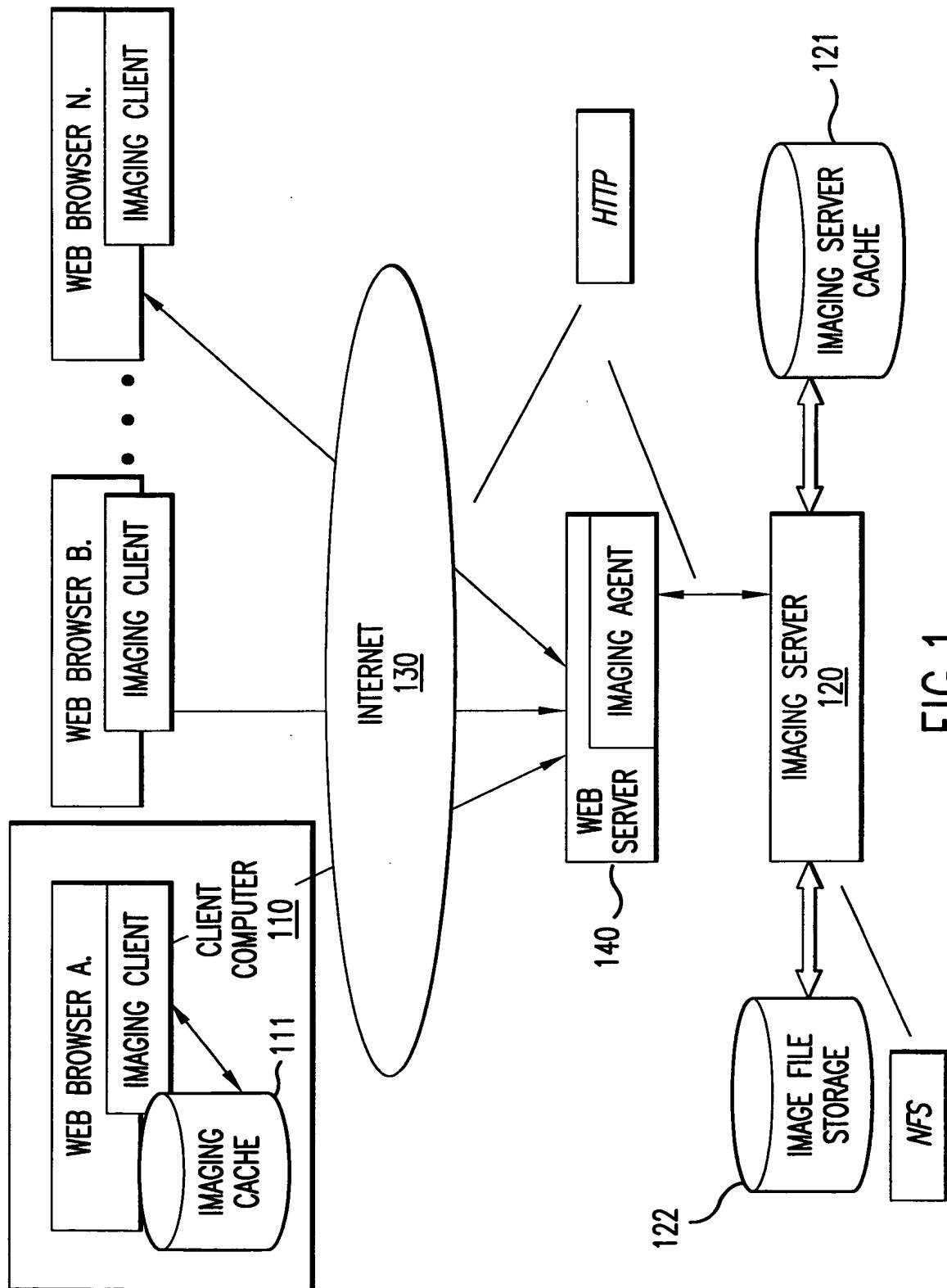
Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 1 of 26

1/26

SYSTEM ARCHITECTURE BLOCK DIAGRAM



Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 2 of 26

2/26

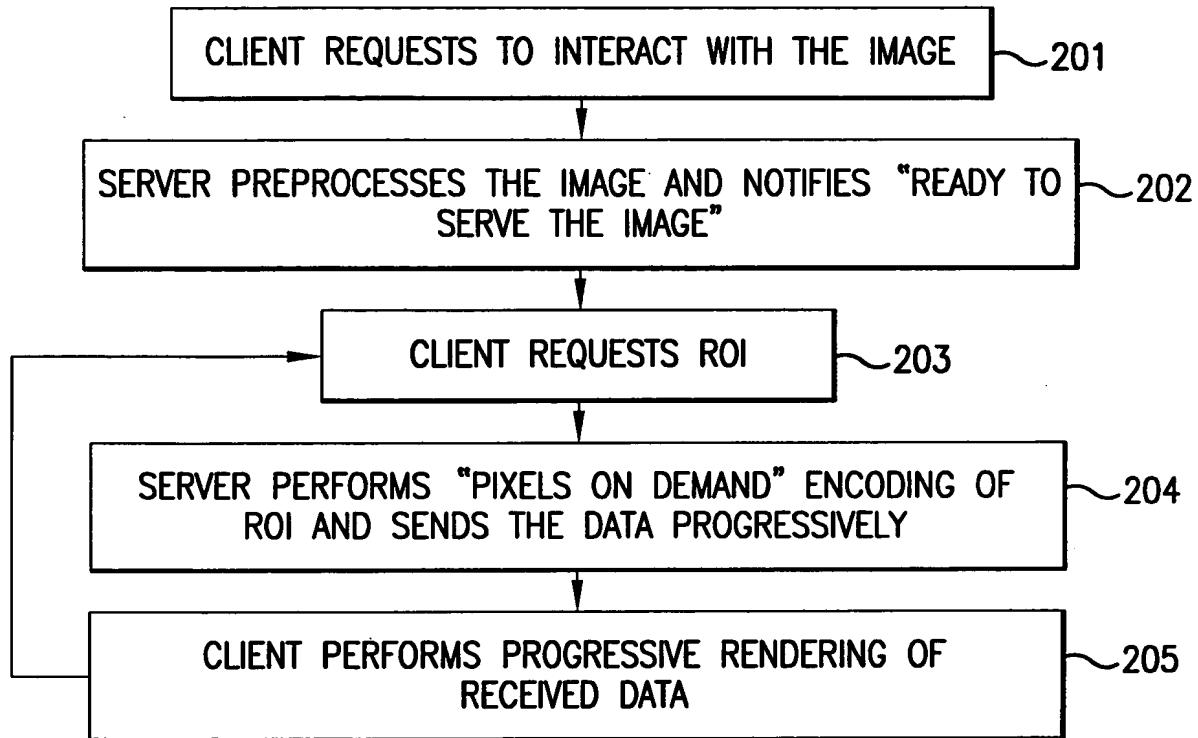


FIG.2

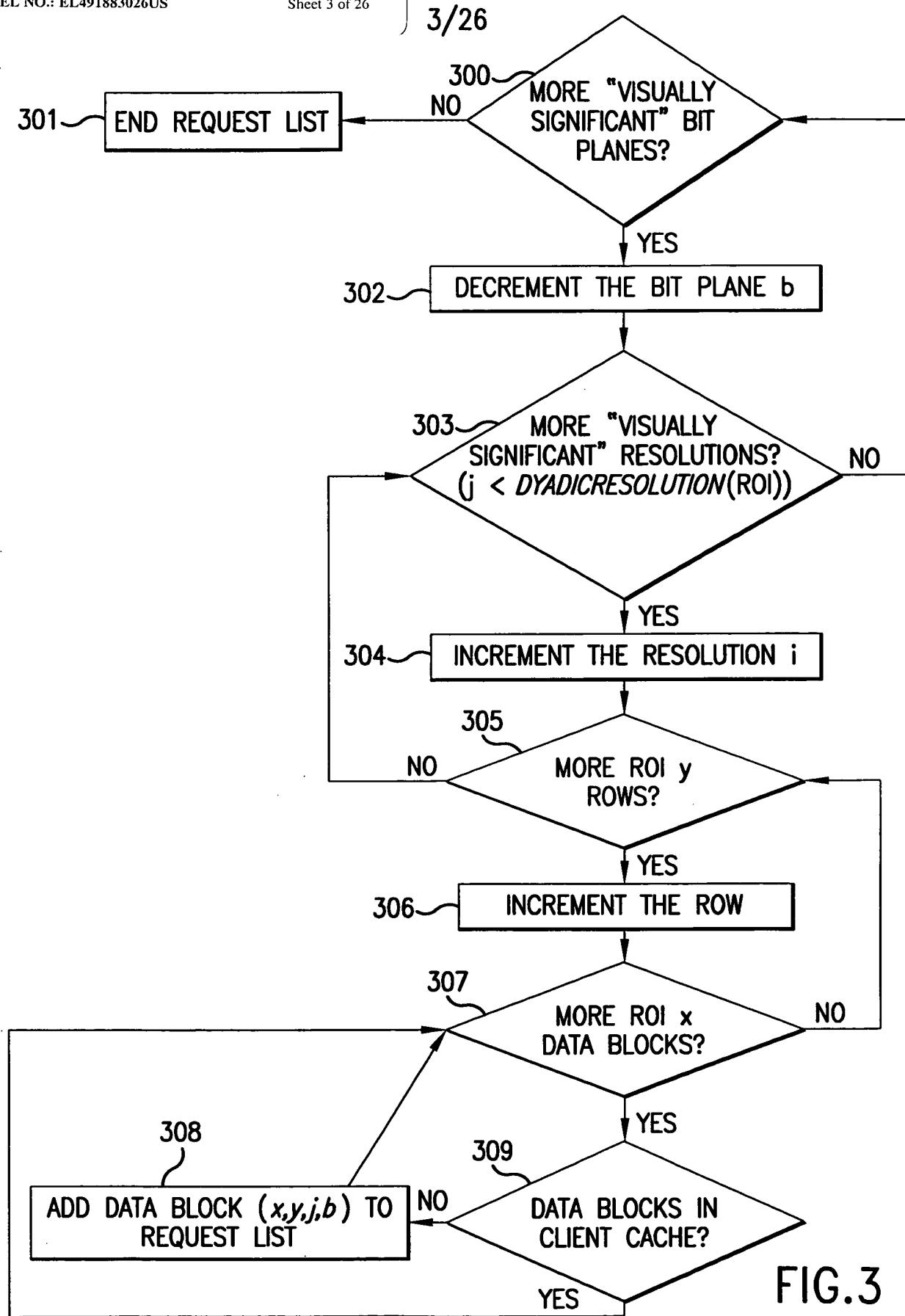


FIG.3

Inventors: Dekel et al.

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 4 of 26

4/26

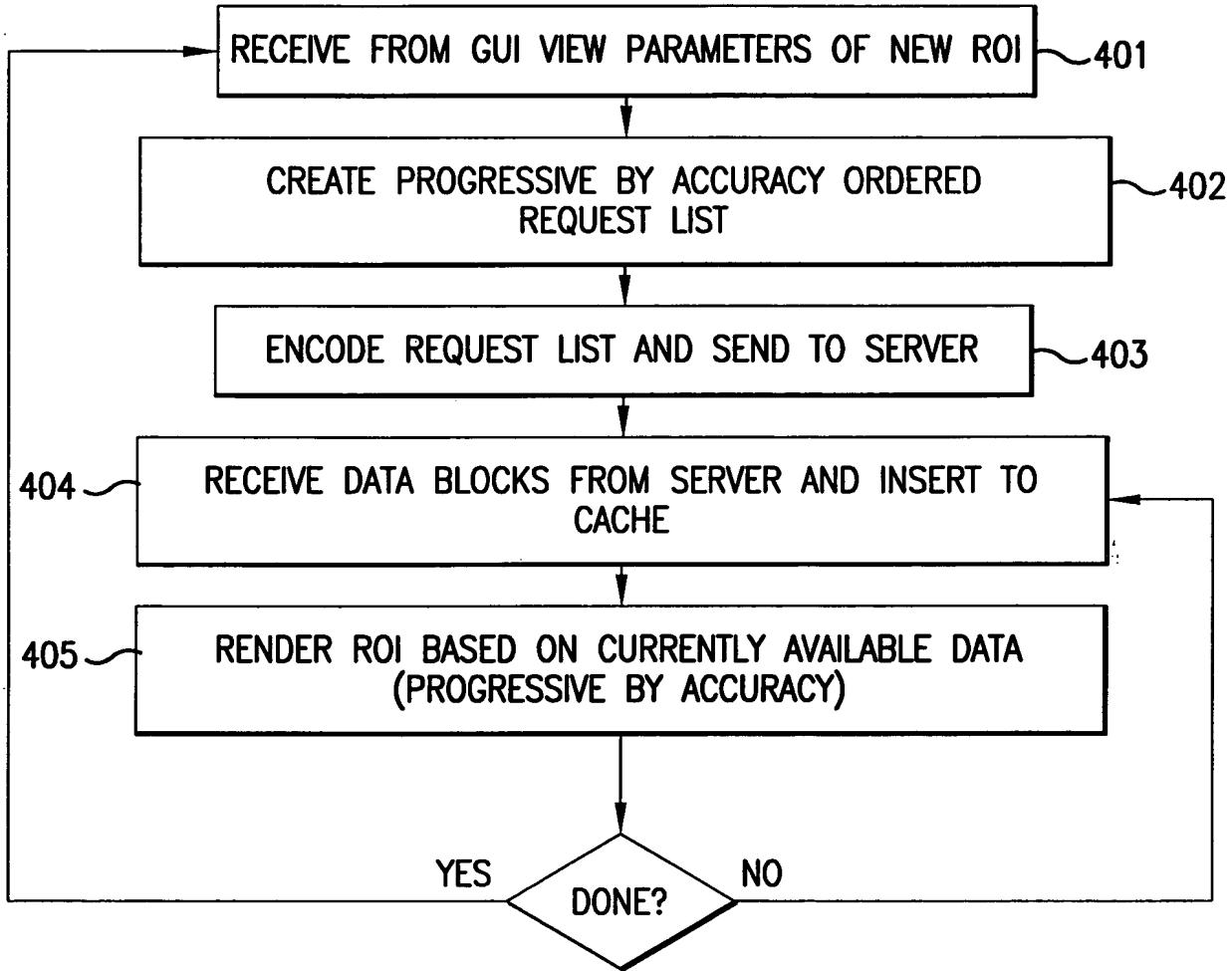


FIG.4

5/26

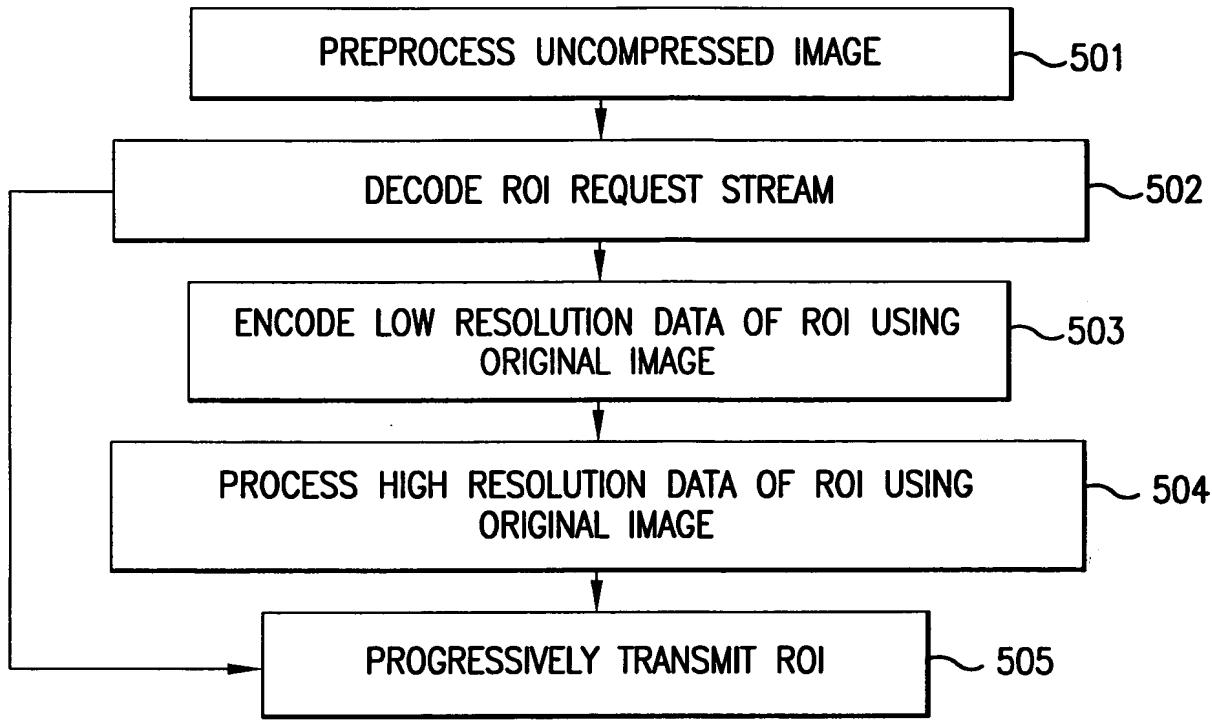


FIG.5

09827366.0
2002-09-12

6/26

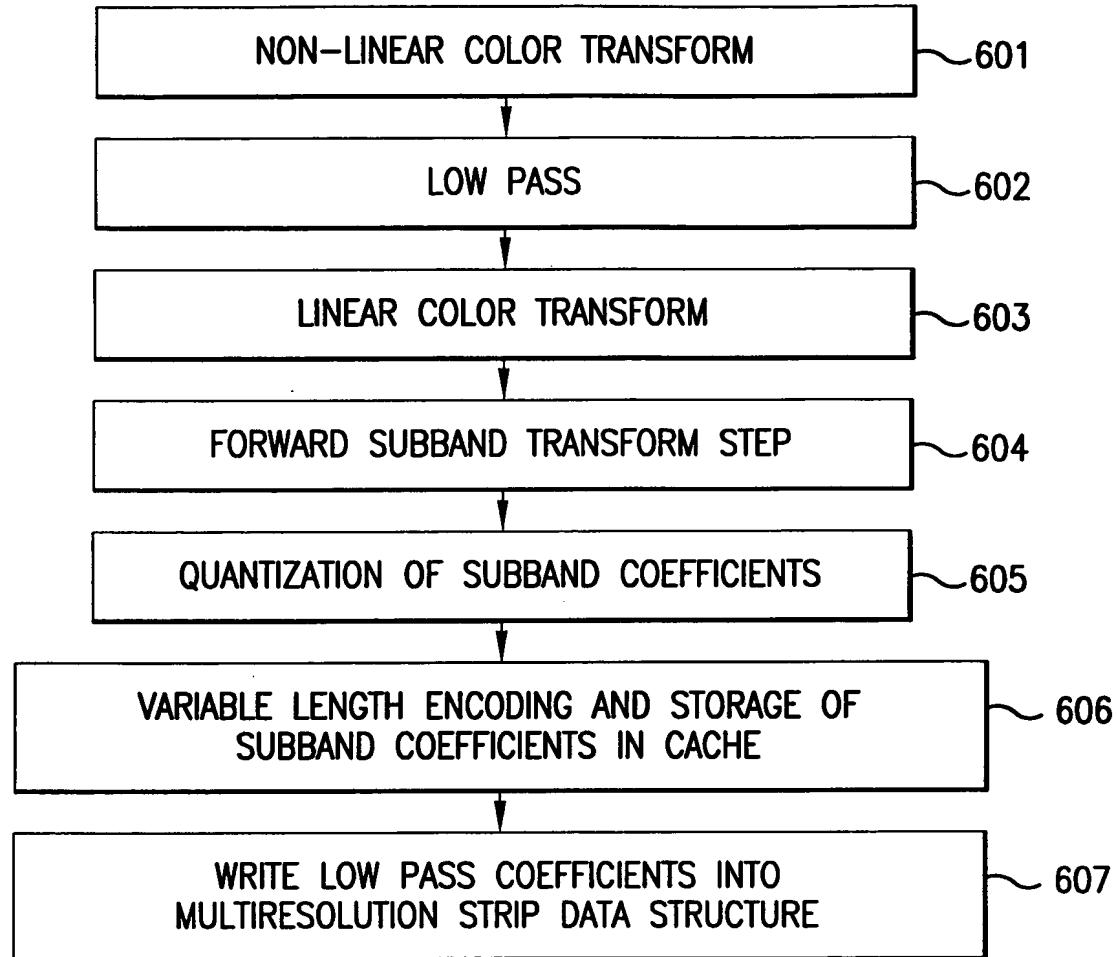


FIG.6

0988729562 - 0204 2002

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 7 of 26

7/26

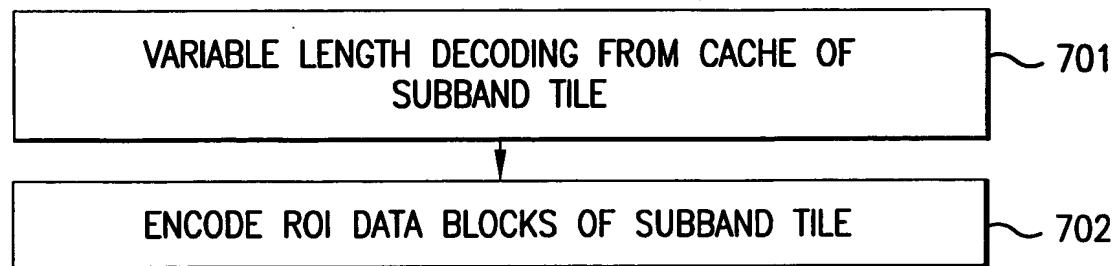


FIG.7

00000000000000000000000000000000

8/26

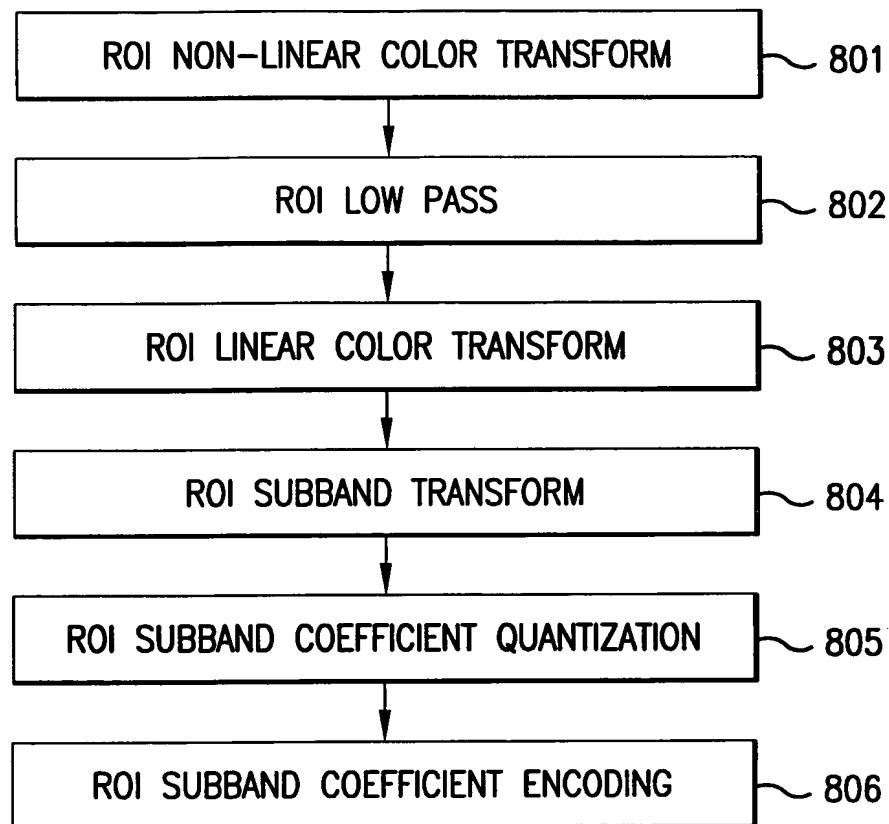


FIG.8

Inventors: Dekel et al.

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 9 of 26

9/26

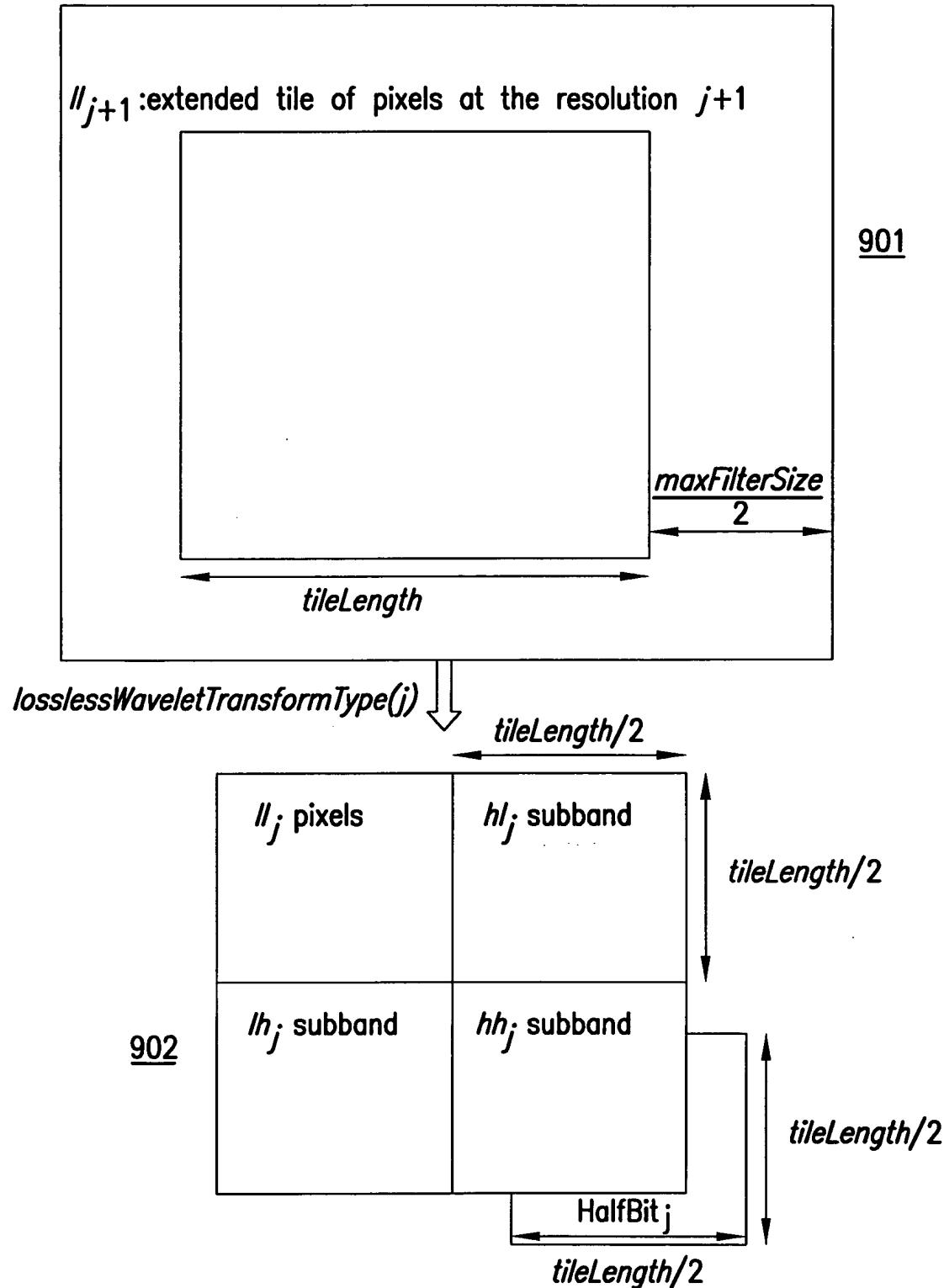


FIG.9

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 10 of 26

10/26

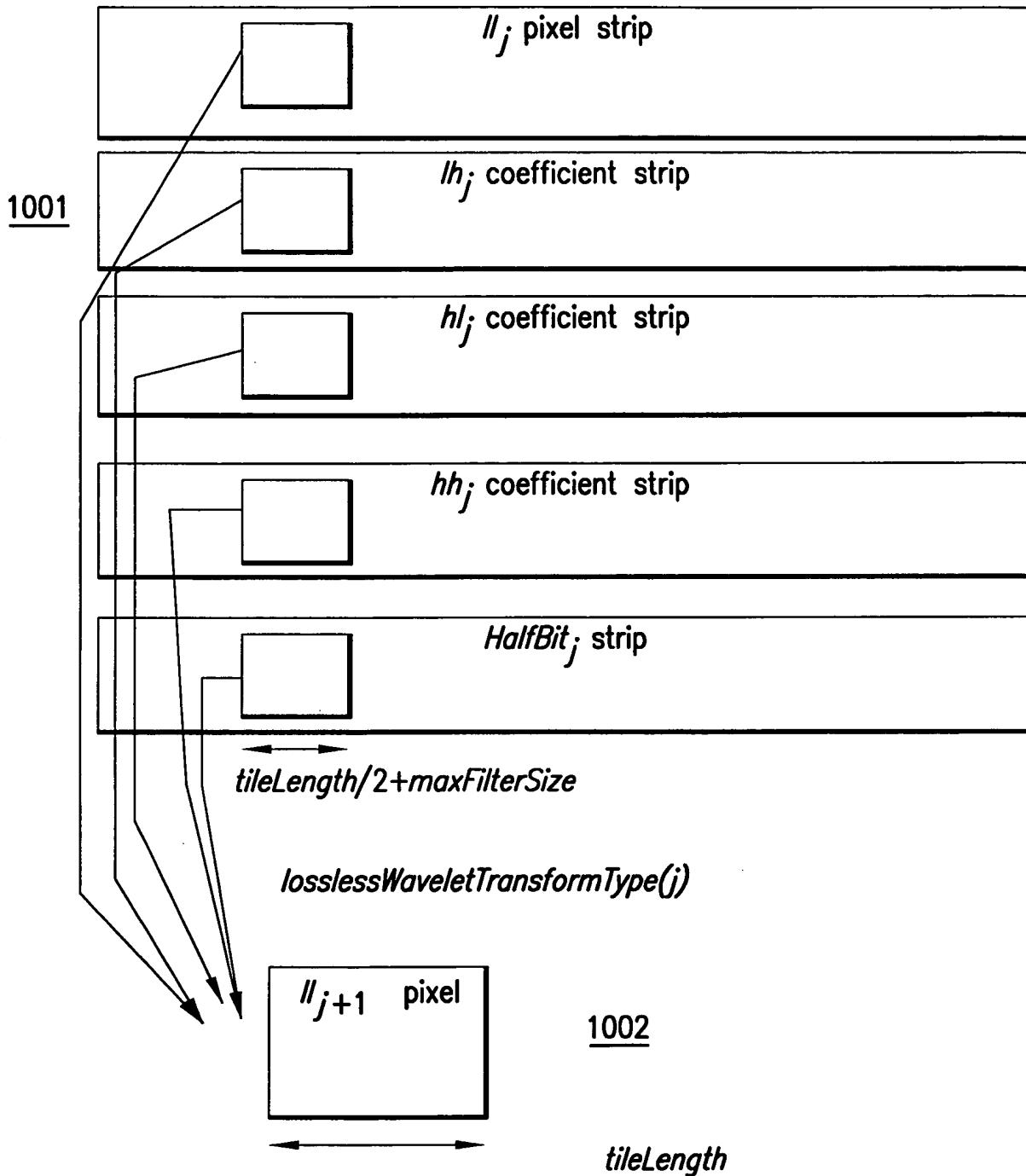


FIG.10

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 11 of 26

11/26

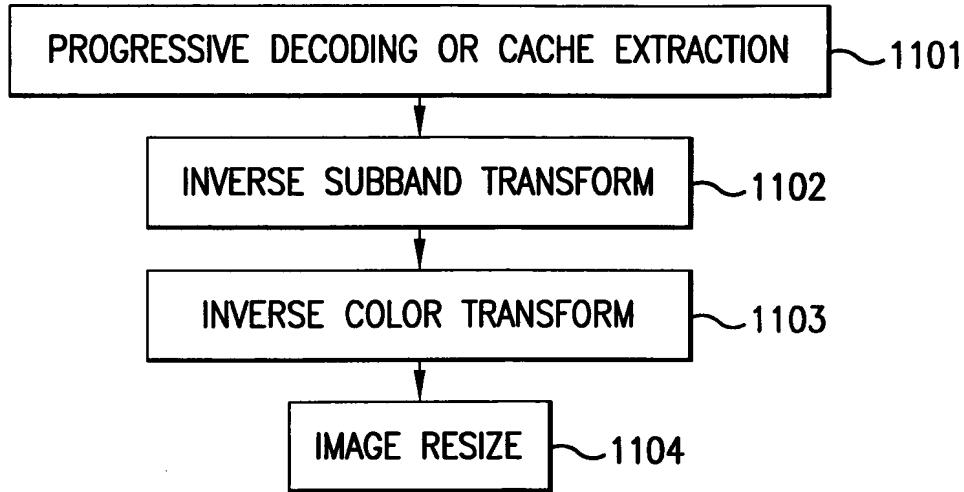


FIG.11

019837862 - 03032002

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 12 of 26

12/26

1201

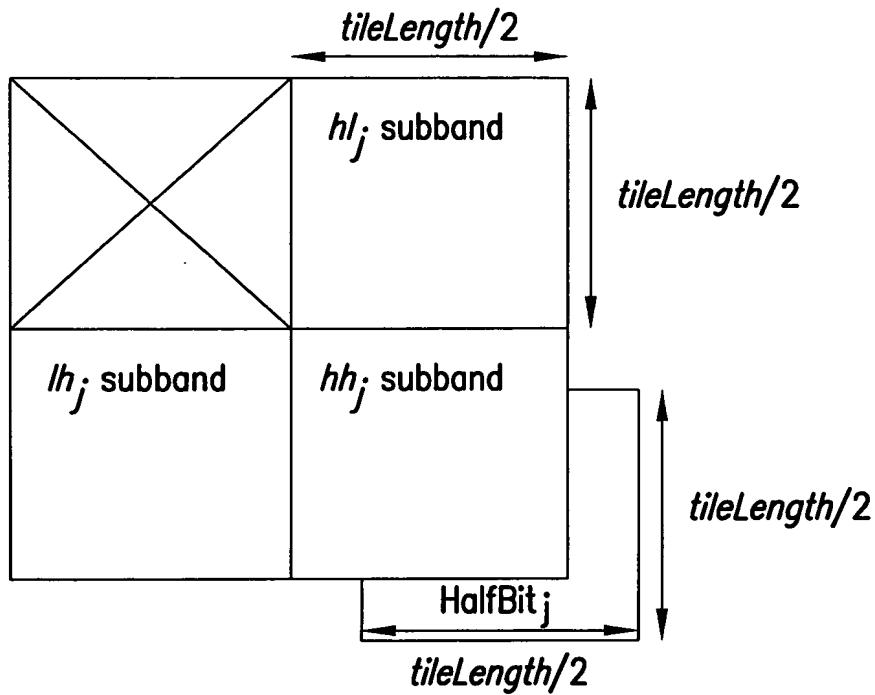


FIG.12

09837862-031206

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 13 of 26

13/26

RGB <-> YUV REVERSIBLE CONVERSION

FORWARD:

$$Y_r = \left\lfloor \frac{R + 2G + B + 2}{4} \right\rfloor$$

$$U_r = R - G$$

$$V_r = B - G$$

INVERSE:

1301

$$G = Y_r - \left\lfloor \frac{U_r + V_r + 2}{4} \right\rfloor$$

$$R = U_r + G$$

$$B = V_r + G$$

FIG.13

09837862-031302

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 14 of 26

14/26

1401

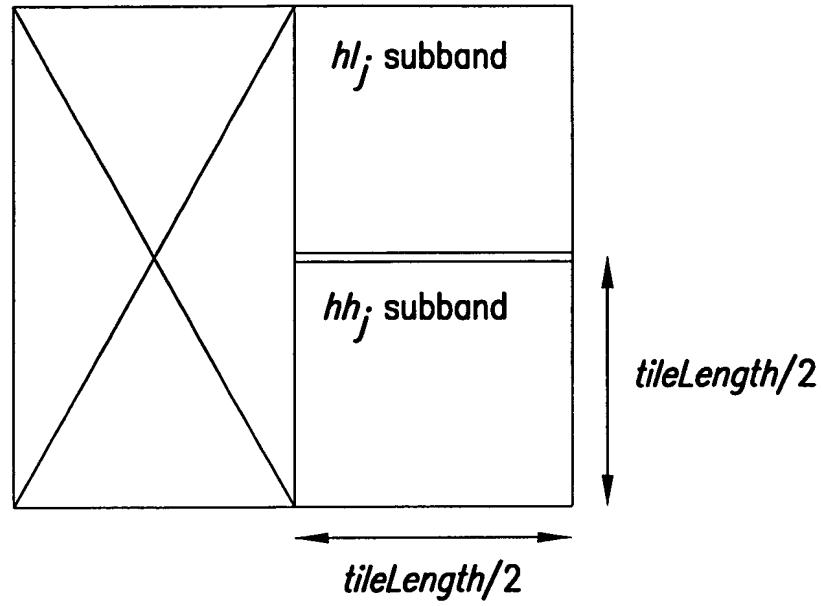


FIG.14

098327862 - 021202

```
bitModel.startModel () ;  
zeroCoefModel.startModel () ;  
coefSignModel.startModel () ;  
  
while (encoder.moreCoef ()) {  
    if (encoder.isCoefReported ()) {  
  
        arithmetic_encode_symbol (bitModel,encoder.reportedCoefPrecisionBit ()) ;  
    }  
    else {  
        if (encoder.isCoefExactZero ()) ;  
        arithmetic_encode_symbol (zeroCoefModel,true) ;  
        else {  
            arithmetic_encode_symbol (zeroCoefModel,false) ;  
            arithmetic_encode_symbol (coefSignModel,encoder.getCoefSign ()) ;  
        }  
    }  
}
```

FIG.15a

```
bitModel.startModel () ;  
  
for (int i = 0 ; i < hBlockSize ; i++) {  
    for (int j = 0 ; j < hBlockSize ; j++) {  
        arithmetic_encode_symbol (bitModel,  
        coefHalfBit [i] [j]) ;  
    }  
}
```

FIG.15b

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE

STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 16 of 26

16/26

```
bitModel.startModel() ;  
zeroCoefModel.startModel() ;  
coefSignModel.startModel() ;  
  
decoder.initializeLSBPlaneCoefScan () ;  
  
while (decoder.moreCoef ()) {  
    if (decoder.isCoefReported ()) {  
        if (decoder.isLHCoef ()) {  
            decoder.updateLSB (0) ;  
        }  
        else {  
            decoder.updateLSB (arithmetic_decoder_symbol (bitModel)) ;  
        }  
    }  
    else {  
        if (!decoder.isLHCoef ()) {  
            if (!arithmetic_decoder_symbol (zeroCoefModel))  
                decoder.setLSB (arithmetic_decoder_symbol (coefSignMode  
1)) ;  
        }  
    }  
}
```

FIG.16a

```
bitModel.startModel () ;  
for (int i = 0 ; i < hBlockSize ; i++) {  
    for (int j = hBlockSize ; j ; j--,p++) {  
        coefHalfBit [i] [j] = arithmetic_decoder_symbol (bitModel) ;  
    }  
}
```

FIG.16b

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE
STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 17 of 26

17/26

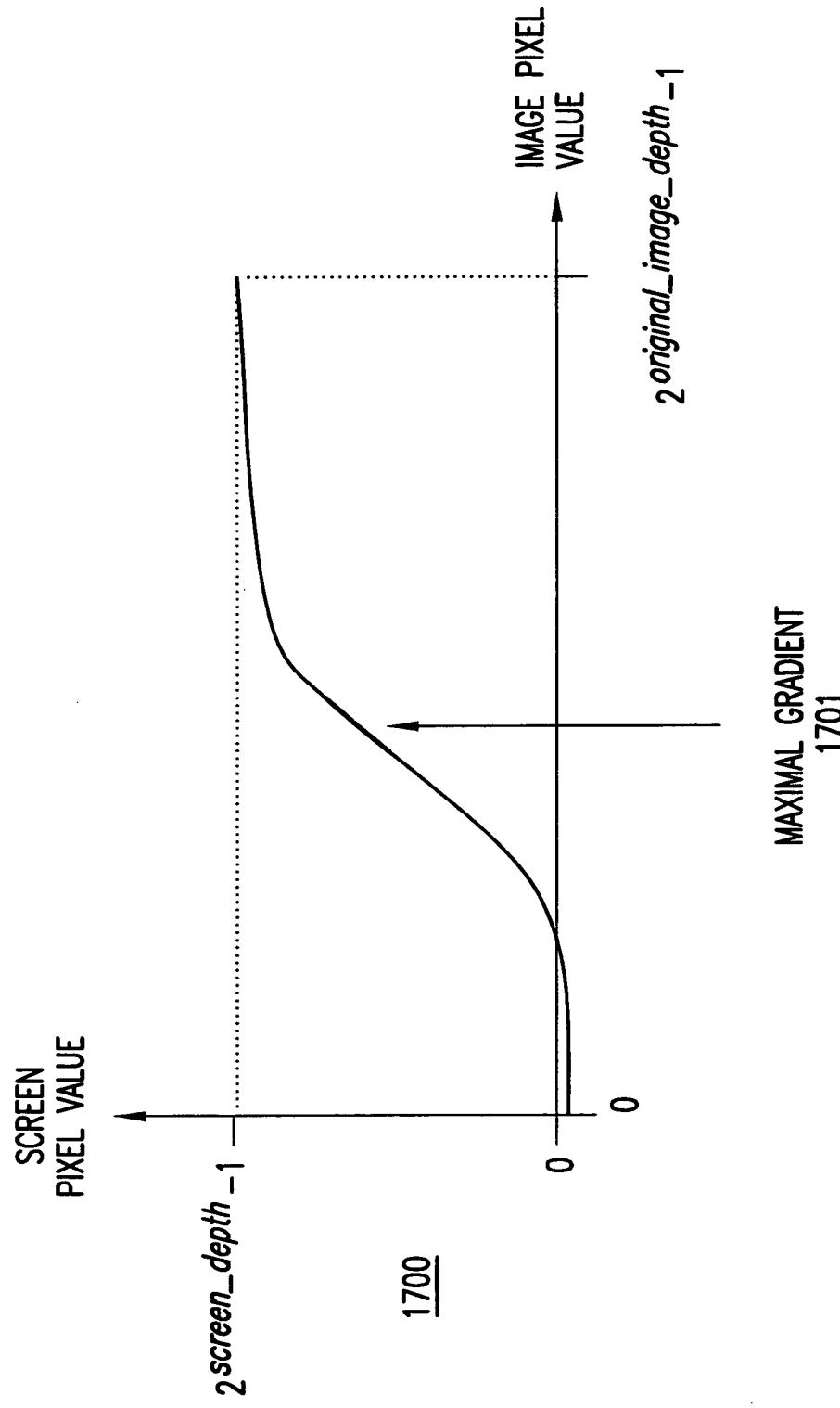


FIG. 17

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

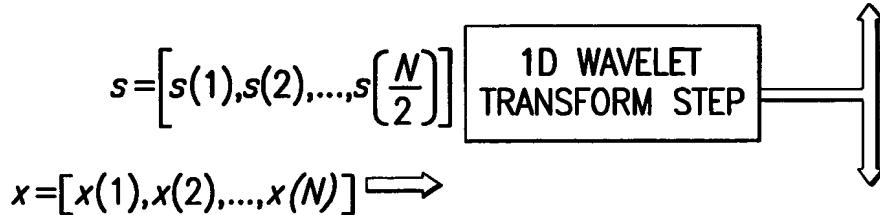
Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 18 of 26

18/26

1800



$$d = [d(1), d(2), \dots, d\left(\frac{N}{2}\right)]$$

$$X = \begin{bmatrix} x(1,1) & x(1,2) & \cdots & x(1,N) \\ x(2,1) & x(2,2) & \cdots & x(2,N) \\ \vdots & \vdots & \ddots & \vdots \\ x(M,1) & x(M,2) & \cdots & x(M,N) \end{bmatrix}$$



1801

2D WAVELET
TRANSFORM STEP

$$\hat{X} = \left[\begin{array}{c|c} LL & HL \\ \hline LH & HH \end{array} \right] = \begin{array}{|c|c|c|c|} \hline & \begin{array}{ccc} II(1,1) & \cdots & II(1,N/2) \end{array} & \begin{array}{ccc} hI(1,1) & \cdots & hI(1,N/2) \end{array} & \\ \hline \begin{array}{ccc} \vdots & \ddots & \vdots \end{array} & & \begin{array}{ccc} \vdots & \ddots & \vdots \end{array} & \\ \hline & \begin{array}{ccc} II(M/2,1) & \cdots & II(M/2,N/2) \end{array} & \begin{array}{ccc} hI(M/2,1) & \cdots & hI(M/2,N/2) \end{array} & \\ \hline \begin{array}{ccc} II(1,1) & \cdots & II(1,N/2) \end{array} & \begin{array}{ccc} hh(1,1) & \cdots & hh(1,N/2) \end{array} & \\ \hline \begin{array}{ccc} \vdots & \ddots & \vdots \end{array} & & \begin{array}{ccc} \vdots & \ddots & \vdots \end{array} & \\ \hline & \begin{array}{ccc} II(M/2,1) & \cdots & II(M/2,N/2) \end{array} & \begin{array}{ccc} hh(M/2,1) & \cdots & hh(M/2,N/2) \end{array} & \\ \hline \end{array}$$

FIG.18

Inventors: Dekel et al.

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 19 of 26

19/26

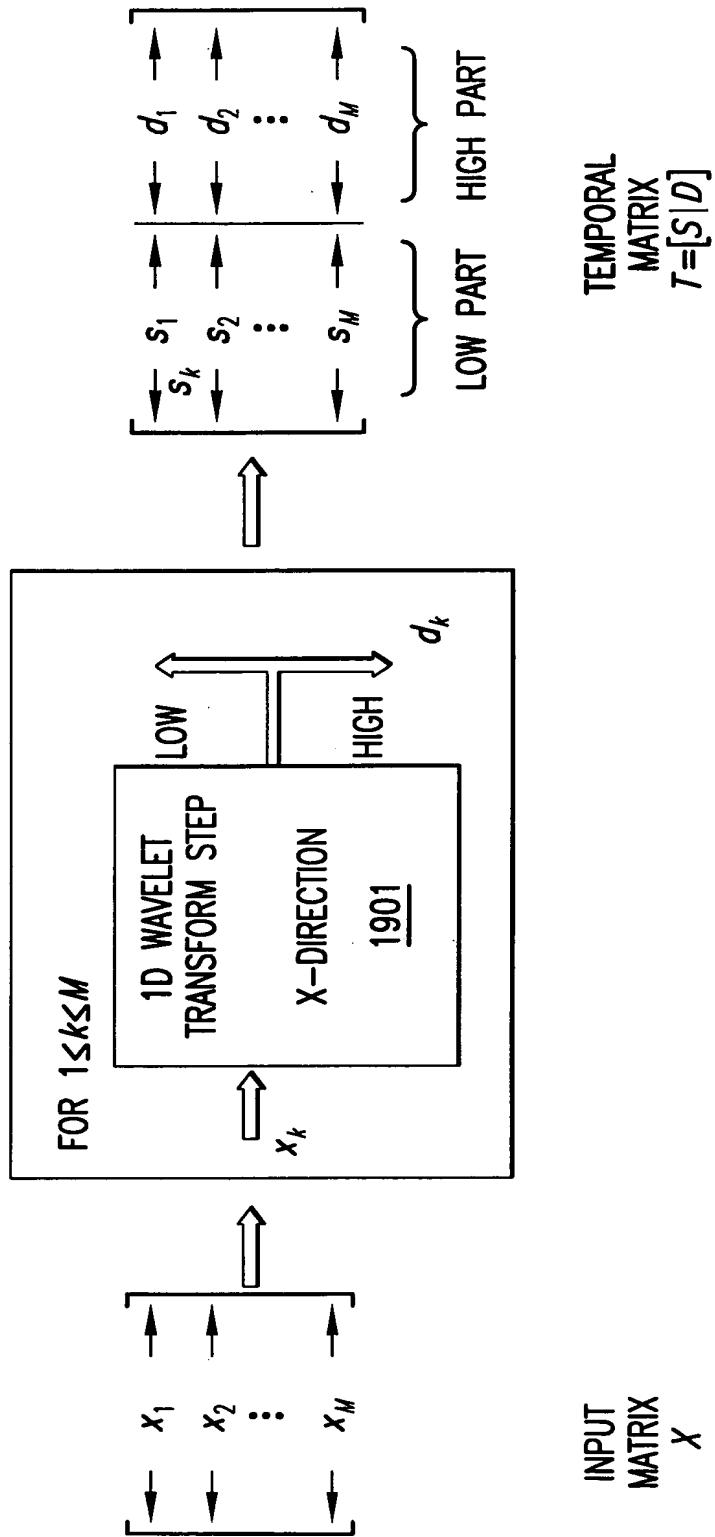


FIG. 19

1901

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

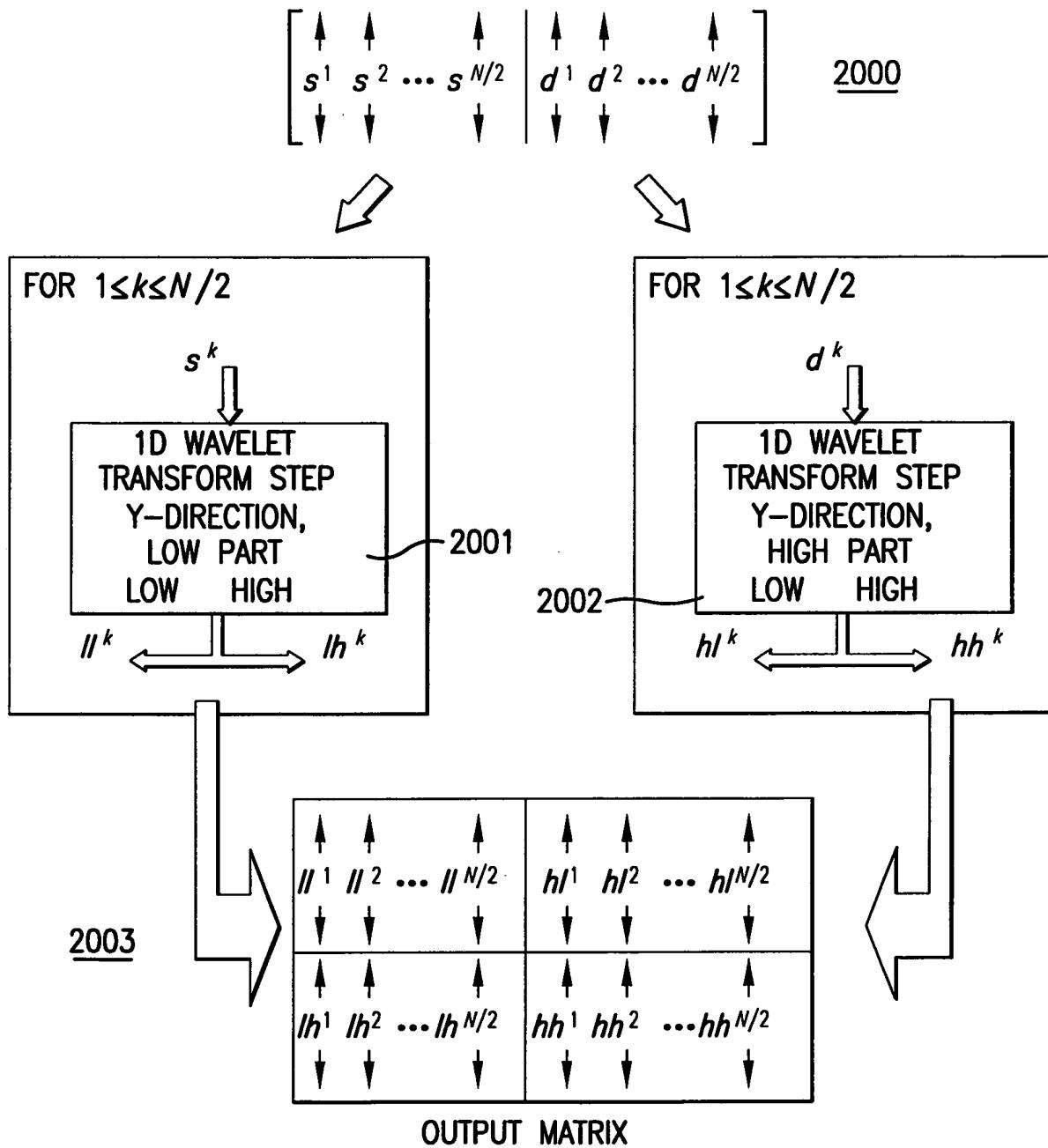
Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 20 of 26

20/26



2004

$$\hat{X} = \left[\begin{array}{c|c} LL & HL \\ \hline LH & HH \end{array} \right]$$

FIG.20

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 21 of 26

21/26

LET I BE THE ORIGINAL IMAGE,



FOR $0 < i < \text{LEVELS}$

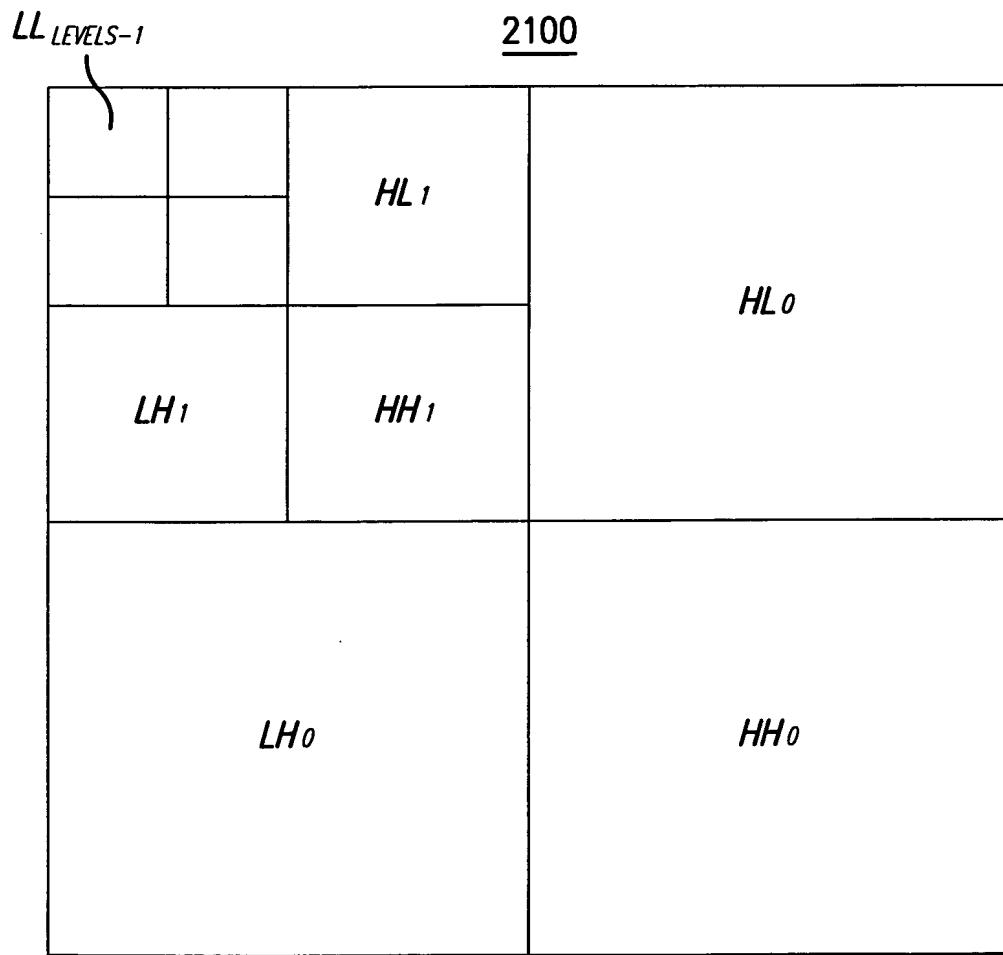


FIG.21

22/26

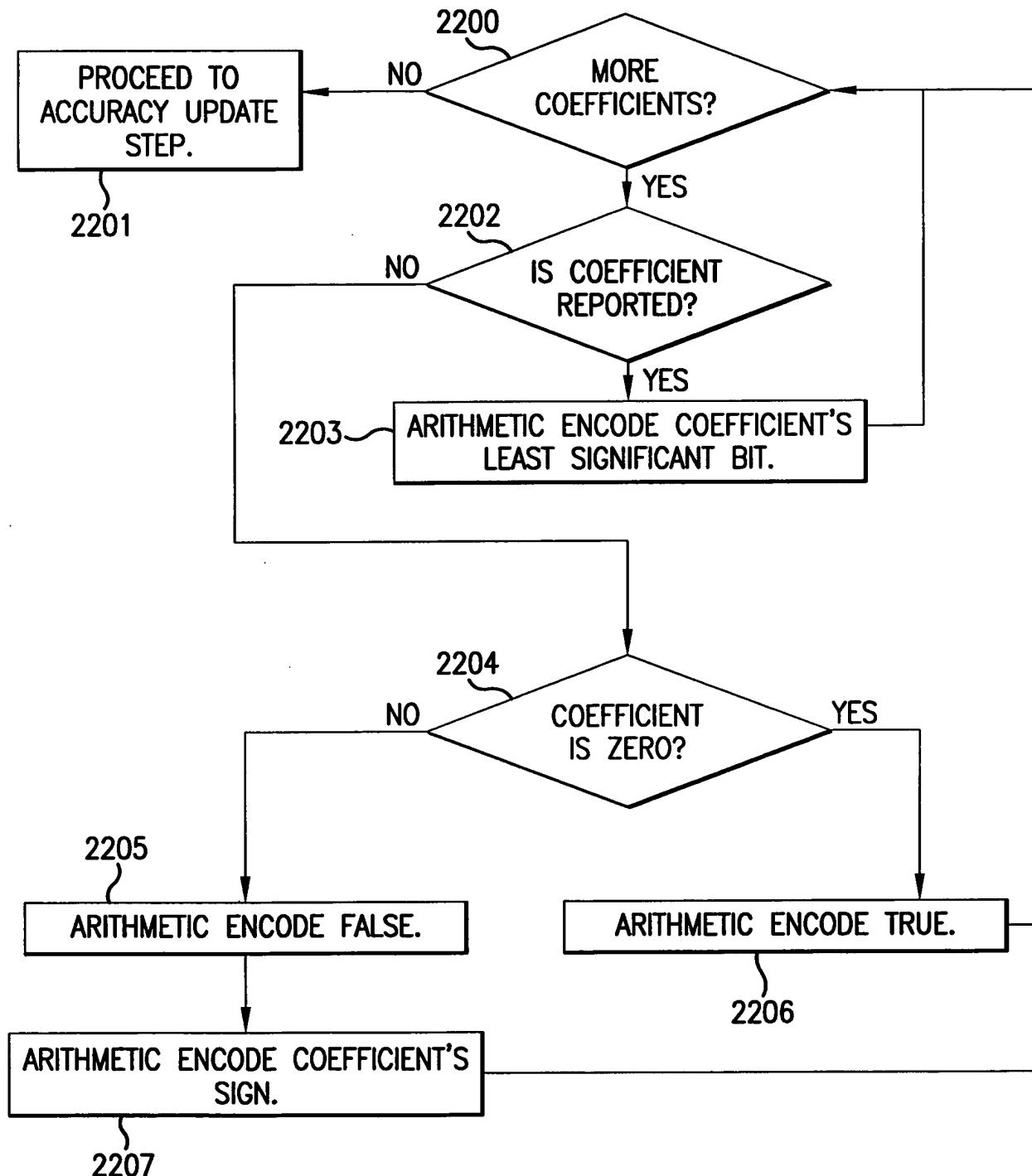


FIG.22

23/26

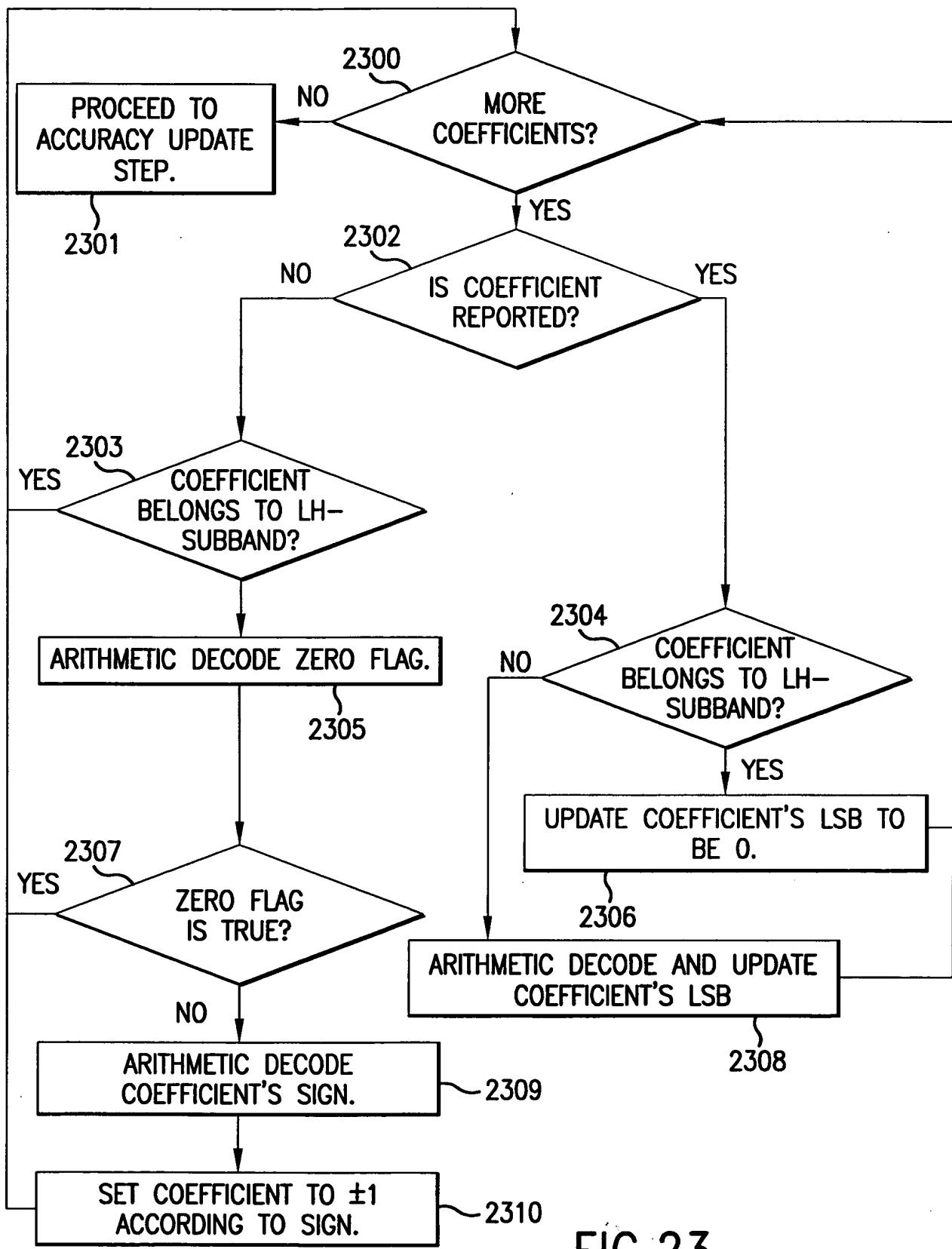


FIG.23

Inventors: Dekel et al.

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

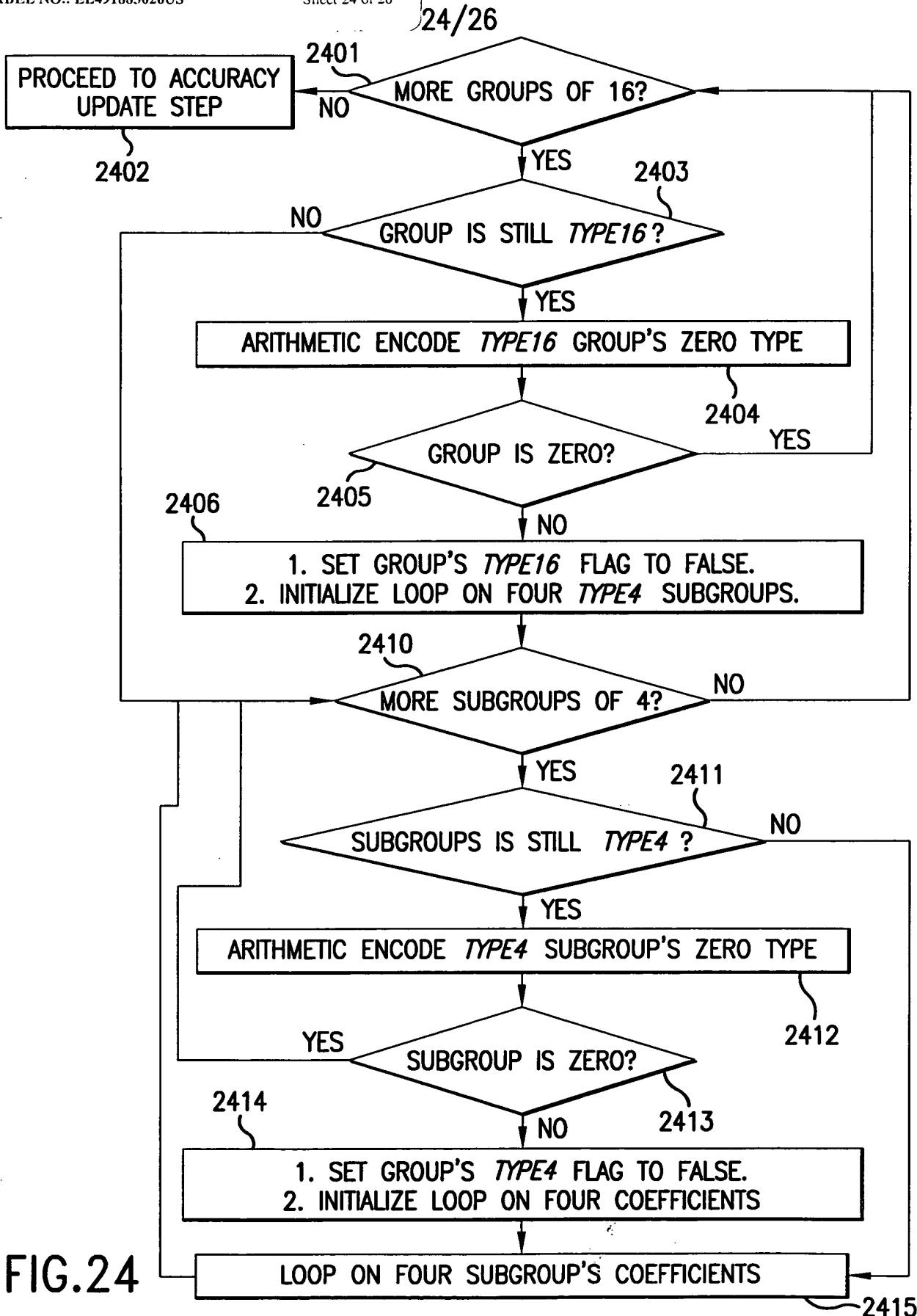
Docket No.: 18104.0011UI

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 24 of 26



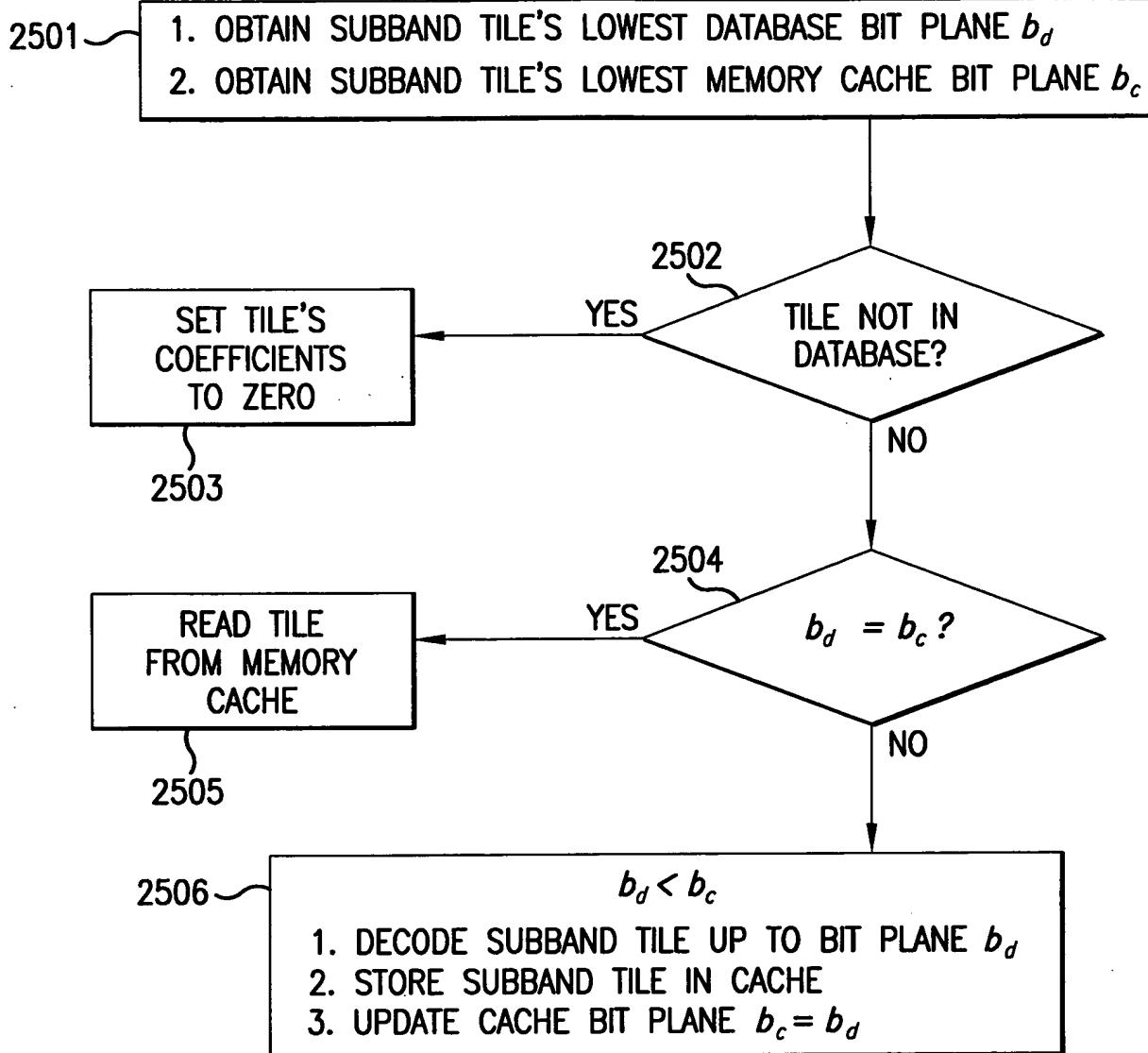


FIG.25

Inventors: Dekel *et al.*

Title: "SYSTEM AND METHOD FOR THE LOSSLESS PROGRESSIVE STREAMING OF IMAGES OVER A COMMUNICATION NETWORK"

Serial No.: 09/837,862

Docket No.: 18104.0011U1

Filing Date: April 17, 2001

Contact: Lawrence D. Maxwell, Esq. (404) 688-0770

EXPRESS MAIL LABEL NO.: EL491883026US

Sheet 26 of 26

26/26

PREPROCESSING MULTIRESOLUTION STRUCTURE

